

Solid-State Guy Lines

So you took the plunge, bit the bullet, and bought that tower you've been dreaming about ever since your license came in the mail. Now, how do you keep it standing? In this photo guide, W8CM looks at an alternative to traditional steel guy wires.

By Mike Baker, W8CM*
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Any ham who has been there will agree: buying and erecting a tower is only part of the story. The "real" work and a significant part of your budget will go into the *guy system*, the cables that keep your tower from falling over on the first windy day. I recently decided to put up a 90-foot guyed Rohn 25G tower in order to stack some 6-meter beams with a rotating tower system so the beams could be mounted on the side of the tower instead of the top (more on this in a separate article). This meant that one of the antennas would be turning between two sets of tower guys. After looking into all the details, I decided to put up the tower with a set of "solid-state guy lines." Note that I did not say "guy wires."



Photo A. Dori Baker, W8YR, and Saleem Banatwala, KC5UHS, begin wrapping Phillystran guy cable in "big grip" steel wrapper. (Photos courtesy of the author)

Introducing Phillystran

Today's ham has two choices for a tower guy system. The first is the old reliable EHS (extra high strength) steel cable, but a very interesting alternative is a product made of clad aramid fiber, called "Phillystran." This is a multiple-strand fiber, similar to the well-known Kevlar™, the material used in bulletproof vests. The fibers are very strong, with a strength-to-weight ratio five times greater than steel, and are covered with a protective extruded outer jacket sheath.

**Mike Baker, W8CM, has been a ham since 1960, and particularly enjoys VHF-UHF weak signal modes. He lives in Van Alstyne, Texas, with his wife and two children, who are all hams as well. Mike is a senior manager of RF engineering for Nortel Networks in Dallas.*

Both the fiber and the sheath are non-conductive, so they won't interact electrically with antennas.

Both EHS and Phillystran are available in several diameters and equivalent strengths. For example, both 3/16-inch EHS and an equivalent Phillystran cable are rated at 4,000 pounds. So what's the difference? First of all, a guying system with Phillystran will cost about twice as much as a conventional steel EHS system, but it could be worthwhile in the long run! Steel guys have a tendency to interact with HF antennas, and, in my case, with the stacked 6-meter beams above and below them.

Normally, the "correct" way to build a ham system is to use insulators in each guy line to "break up" the guys into lengths that aren't resonant on any of the

ham bands. You have to go through the very tedious process of building multiple steel guy lines with all those insulators and clamps to fully appreciate how much work it really takes, compared to the simple build-up for a Phillystran line. Also, once you've built up your steel lines and installed them, you'll find that they tend to stretch for quite a while until all the parts take their set, so you'll have to readjust the guy wire tension often for a while. The Phillystran cable, on the other hand, is set once on initial installation and doesn't need much readjustment. I feel that when you take into account all the extra time it takes to build up those insulated steel cables, plus repeatedly retensioning them, your time savings more than compensates for the higher initial cost of the Phillystran cable.

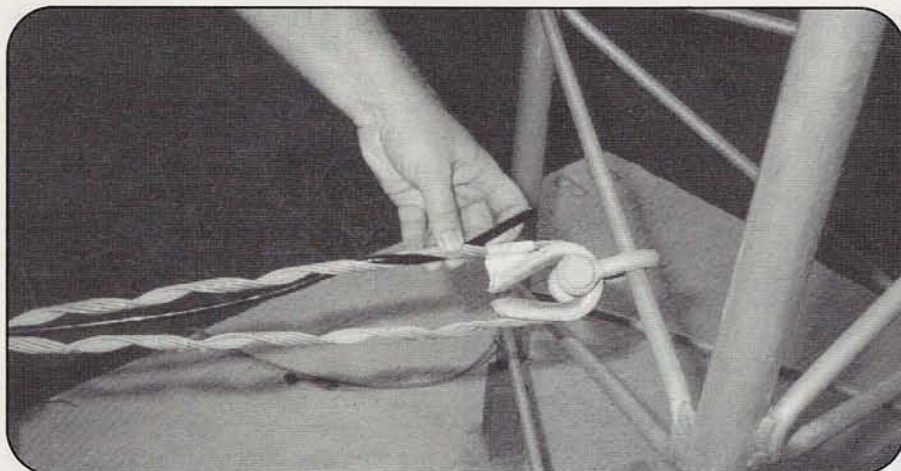


Photo B. Detail view of the "big grip" wrapping process. Note that only a couple of inches of the Phillystran cable extend beyond the initial wrapping point.

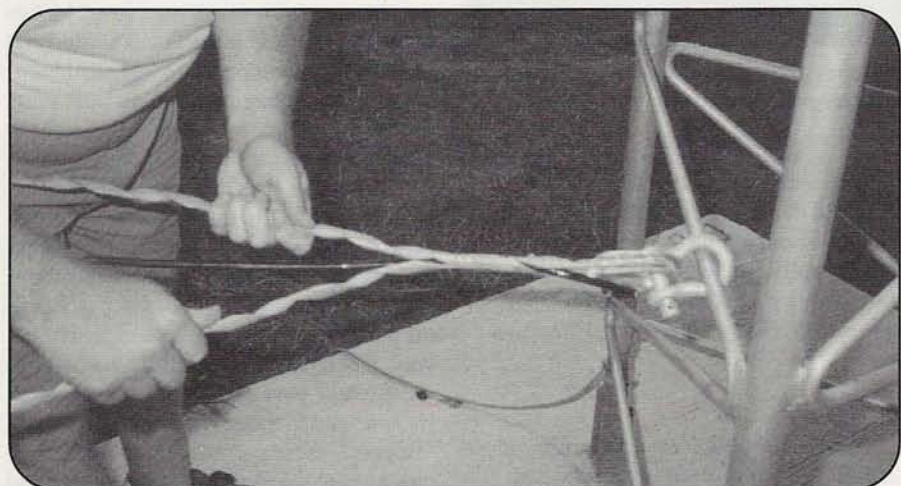


Photo C. The wrapping process continues as the Phillystran cable is secured to the "big grip."



Photo D. Continuing to wrap the Phillystran in the "big grip." Patience will be required.

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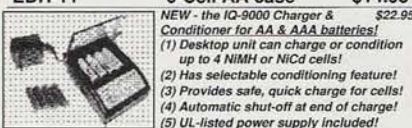
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Photo E. As you approach the end of the "big grip," the cable becomes quite stiff and may be difficult to work with. The good news is that you're almost done.

OK, now that you're sold on using a nonmetallic guy system and have brought home the goodies, you should know that building and installing a Phillystran cable is simple, but it takes a little getting used to compared to how you may have made up steel cables before. The Phillystran system uses special steel "big grips" to wrap around the line and hold it in a fashion much like those kids' toys that grab your finger and won't let go. An instruction sheet comes with the line when you

buy it, but you'll find it helpful at this stage to get some assistance from someone. You can put on the big grip yourself, but it really, really helps to have someone help by providing a light tension on the line while you are doing this.

Preparing the Cable

Photo A shows my daughter, Dori Baker, W8YR, and friend, Saleem Banatwala, KC5UHS, starting this

process. In Photo B, you can see a close-up view of how the process is begun at the end of the line. Here, it helps to use a standard shackle and pin to temporarily anchor the required U-shaped steel Phillystran thimble to something like a tower rung. The special Phillystran big grips are marked by the factory with a dab of paint which tells you where to start wrapping, with the cable protruding a couple inches beyond.

Now, this is important: if you've installed big grips on steel cables in the past, *do no*, repeat, *do not* think you do it the same way with this line; and *do not* use the same kind of grips you used on the steel cables. Because the cladded Phillystran line can be distorted if the grips are improperly installed, it's important to start with just a couple of inches in the big grip. Once the line is started and your friend is supplying a little mild tension, you then begin wrapping both parts of the big grip around the line, using both hands to wrap each big grip piece equally around the line as shown in Photo C (the Phillystran is the black cable in the center with the steel grip halves being wrapped around it). The big grip is several feet long, so this process just keeps on as shown in Photos D and E. By the way, when you get to the last couple inches, it really gets to be stiff, so be patient (it's a good thing you can't see my "patient" expression in Photo E). Final touches are to put a plastic cap on the end of the line, cemented with something like

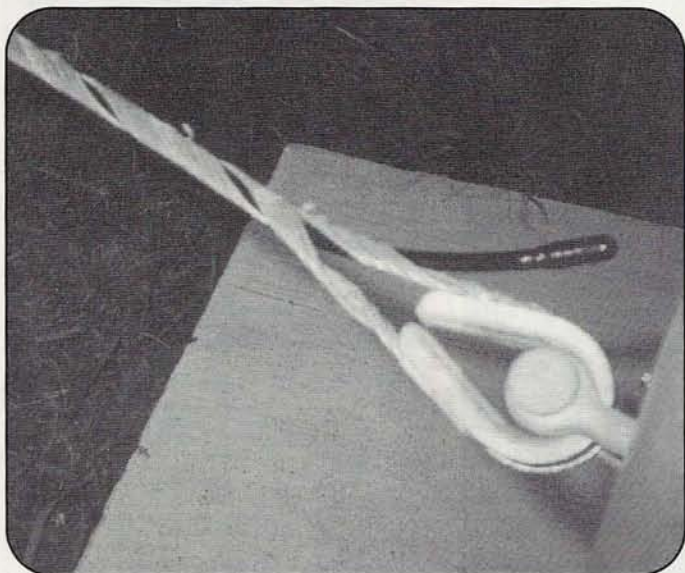


Photo F. Finish off the wrapping job by applying a plastic cap and silicone sealant to the end of the Phillystran cable, shown here sticking out from the bottom end of the "big grip."



Photo G. A heavy-duty tie-wrap at the top end of the "big grip" will ensure that everything stays in place and that you don't have to repeat the wrapping process (except on the other cables!).

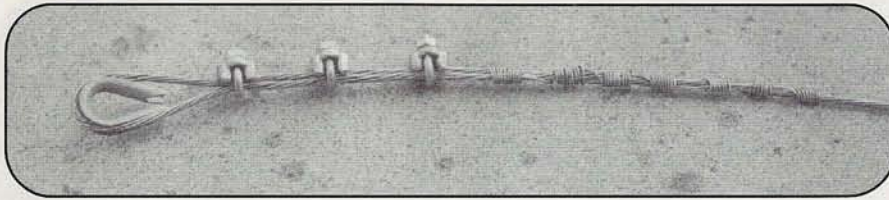


Photo H. Phillystran's manufacturer recommends using a short "tail" of EHS steel cable at the ground end of the guy line. W8CM found several benefits in doing so. See text for details of "serving" the cable (twists at far right) and attaching the cable clamps.

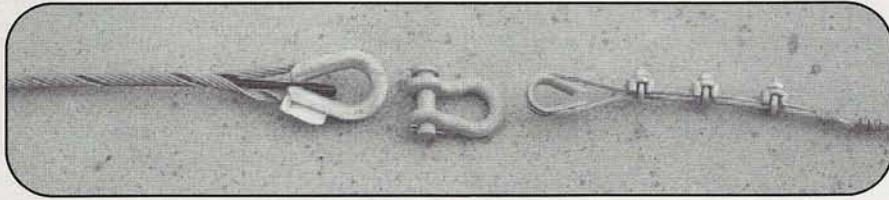


Photo I. The Phillystran cable (left) is connected to the EHS steel "tail" (right) via a 1/2-inch shackle (center).

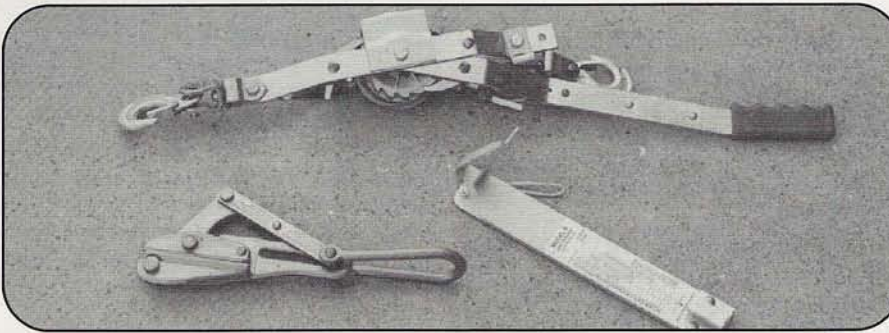


Photo J. Three helpful tools for installing and adjusting your guy lines. At the top is a wire-rope ratcheted tensioner and hook tool called a "come-along." The device at the lower left is a cable clamp that helps you attach the come-along, and on the lower right is a tension gauge to make sure your cables are pulled to the correct tension level. See text for details.

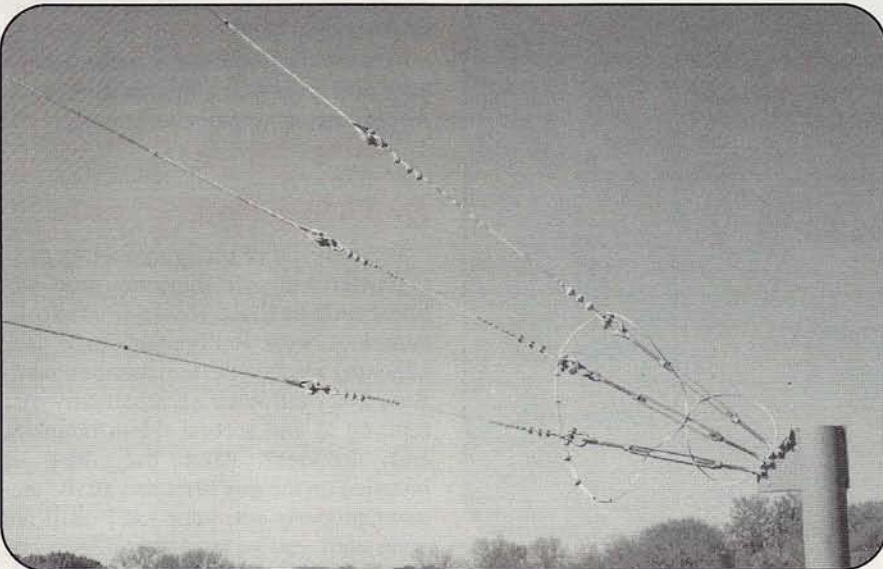


Photo K. Here you can see the connections between the Phillystran cable (far left), the EHS steel "tails" (center), and the turnbuckles that attach to the support post for the guy lines. See text and Photo L to find out about the loop of wire at the far right.

silicone sealant, as shown in Photo F, and to put a black tie-wrap near the end of the big grip as shown in Photo G.

Now for another interesting twist: the Phillystran company recommends that, for ground-mounted guy systems, you use a short steel cable at the bottom end to preclude damage from vandalism and/or grass fires. As a favor to the lawn mowing operation, my system used a massive steel pipe to get the guys above head level, but I also decided to use short steel tails. In addition to the reasons cited by Phillystran, I found two more reasons to use the short steel EHS tails. First, the steel tail gives you something to clamp onto when installing the guy line—the Phillystran is very strong but you really do not want to risk damage to the outer cladding by any mechanical clamping. Second, the available guy line tension gauges are calibrated for steel cables, so having a length of steel cable in series with the Phillystran gives you the ability to accurately measure the tension in the guy line while using a standard gauge.

Photo H shows one end of a steel EHS cable tail. As you can see, doing this properly (and you *DO* always do it by the book, right?) requires installation of three cable clamps along with *serving* each of the seven EHS strands around the cable. "Serving" is the process of taking each of the EHS cable's seven strands and wrapping it around the main cable and the other looped back strands, one by one, so that the first serve takes the first strand around the other six and the main line, then the second serve takes the second strand around the next five, and so on until the final single strand is wrapped around the main line (see the right-hand side of Photo H). Some hams tend to omit serving the seven strands, but this is necessary to comply with prescribed codes.

By the way, don't forget that there is definitely a proper way to install the cable clamps on the wire: make sure to put the "U" of the clamp around the "dead," or wrapped-around, part of the cable (again, see Photo H). Now you have to connect each EHS tail to its corresponding section of Phillystran. Photo I shows the hardware and method of coupling the two lines with a 1/2-inch shackle.

Installation on the Tower

Now that you've gotten the Phillystran guys and EHS tails assembled and are ready to install them on the tower, there are several items that will make the job

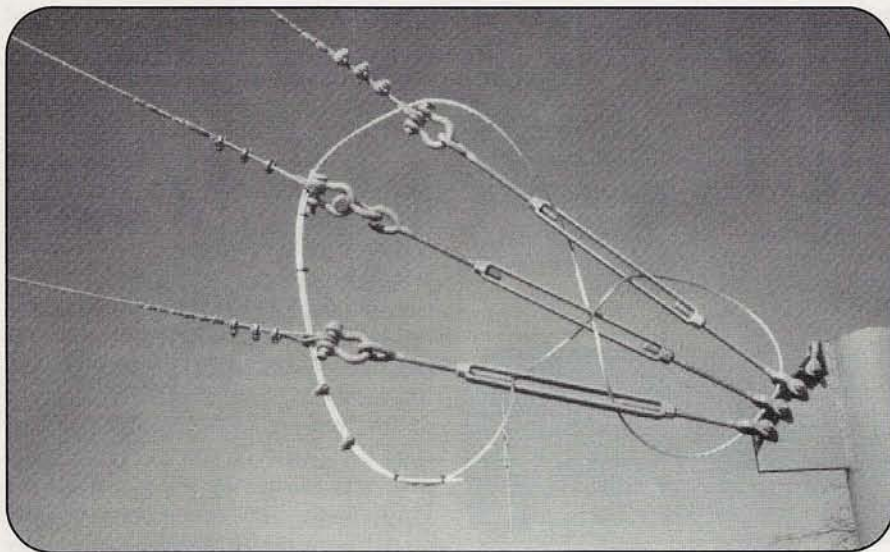


Photo L. Close-up view of the connection point to the support post for the guy lines. The loop of EHS steel cable passes through each of the turnbuckles to keep them from turning accidentally, and to catch a loose cable in the event of turnbuckle failure. See text for details.

easier. These are shown in Photo J, and include a common hardware store wire-rope ratcheted tensioner and hook tool called a “come-along” (at top in photo) to take the initial tension on the guy system when you’re installing the lines with the turnbuckles (you’ll need three, one per guy line). Also shown is a nifty cable clamp (lower left), made by Klein, that grabs the EHS line (*NOT* your Phillystran!) and gives you a way to hook on the come-along (again, three are needed). There’s also a simple, inexpensive ten-

sion gauge, made by Loos (lower right), which works by simply hooking the gauge over the line, pulling to a calibrated mark, and reading the tension from a table printed on the gauge—this gauge gets my vote for the neatest thing since sliced bread.

It is most definitely **NOT** just good enough to snug up the guy lines to where you think they “feel about right.” The guy line must be set to work at 10% of the line’s rating; in the case of my tower with $\frac{3}{16}$ -inch EHS tails and equivalent

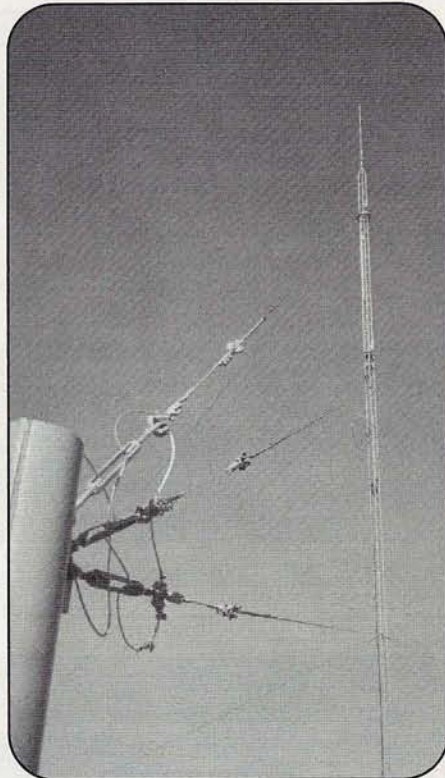


Photo N. The finished product. Assuming you’ve done everything properly and have met all of your local building codes, the tower should now be safe and secure enough for you to climb on up and start installing your antennas. Have fun!

Phillystran, which both were rated at 4,000 pounds per the tower manufacturer’s specification, that meant setting for about 400 pounds tension. Actually, the Phillystran manufacturer recommends an initial setting at 15% of the line’s rating, which lets the line settle in at the desired 10% and gives you a one-time, set-and-forget tensioning procedure.

One More Safety Issue

By now you’re probably feeling pretty pleased with your shiny new set of guy lines, such as those shown in Photo K, complete with Phillystran, EHS tail, adjusting turnbuckle, and assorted hardware. But wait! What’s that squiggly wire running in and around the turnbuckles and shackles? After everything is installed on the guy lines and all the tensions properly set, your job is still not done until you’ve paid attention to one final matter of guy line safety. It’s possible that a turnbuckle might fail, and it’s possible that a turnbuckle might turn and loosen with wind and guy line vibration.

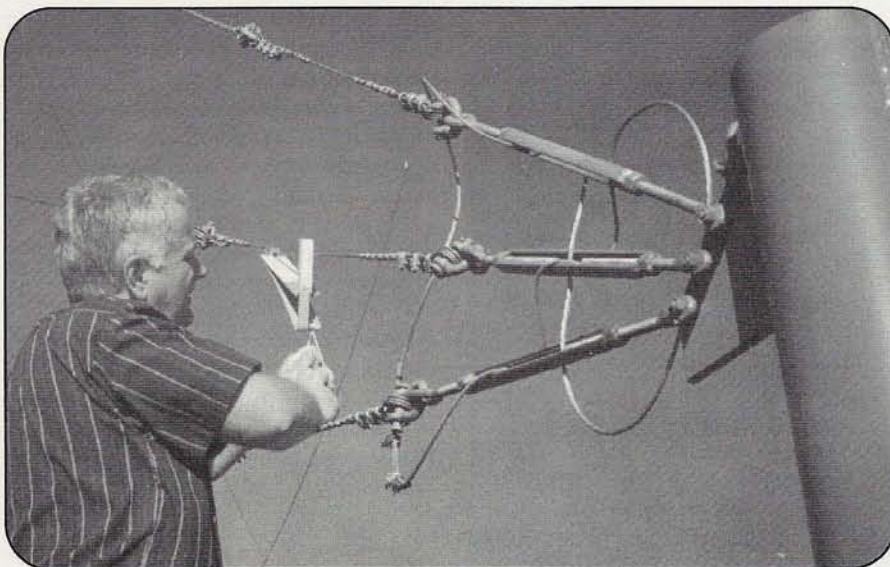


Photo M. The author uses his Loos tension gauge to check on the tension of the guy lines. Tension must be set to 10% of rated line capacity, and Phillystran’s manufacturer recommends an initial setting of 15% to allow the cable to settle in at 10% without needing further adjustment.

Basics: Towers and Guy Lines

Towers come in many flavors, such as self-supporting, crank-up, tilt-over, and guyed. A guyed tower depends entirely on the guy system to keep the tower up and the antenna load supported. The base on a guyed tower serves only to anchor the bottom, and it carries little load in comparison to the guy lines. The tower top antenna load will be specified by the tower manufacturer in "square feet," which can be compared to the wind load square feet in the antenna manufacturer's specifications. Don't exceed the tower rating, and a little safety margin is advisable as well.

Tower ratings and designs normally focus on local conditions of prevailing wind conditions. Some areas require minimum designs for 70-mph winds, while other areas require minimum designs for higher wind conditions. The tower manufacturer and vendor should be able to provide this standard data. Such data is found in the Electronic Industries Association Standard EIA-222-D, American National Standard A58.1-1982, and the 1994 Uniform Building Code. Of course, there's nothing wrong with designing a tower to higher wind conditions than the minimum. I design everything to nominal 90-mph winds, even though the minimum for the Dallas area is 70 mph—the trade off here is project expense versus peace of mind when those gusts come in.

Guy lines are normally installed in sets of three, spaced 120 degrees apart around the tower, and the rule of thumb is that the top guy should come to ground at a distance from the tower of 80% of the tower height (for example, a 70-foot tower would need a top guy to go out to 56 feet from the base). The exact number of sets of guys on the tower from top to bottom depends on the tower design, tower height, and rated antenna loading at the tower top; this is beyond the scope of this article and is available from the tower manufacturer.

The means of anchoring the guy lines in the ground also varies, from simple screw in devices to substantial concrete forms, depending on the tower and local soil conditions. Consult the tower vendor and local experts. Check with your local homeowner and building codes regarding any tower project, and if possible get local hams can assist you. Putting up a tower is not a trivial project, and doing it correctly requires proper preparation and installation. Once done, though, the tower will provide you with many years of ham radio enjoyment.

The mandatory safety measure here is to safety-wire the entire set of guy lines with a short piece of EHS as shown (see detail in Photo L). The EHS is wound so that the wires enter the turnbuckles from opposite directions, keeping the turnbuckles from turning, as well as providing a safety loop in the event of a turnbuckle failure.

Now the job is almost done. All that remains is to make a final check of the guy line tension, as you see me doing with the nifty Loos gauge in Photo M, and then to look over at the tower you've just guyed (it might look something like Photo N), pat yourself on the back, and then realize that "all" you have to do now is install the antennas on the tower! ■

Resources

Phillystran cable, big grips, thimbles, and end caps; EHS steel cable, turnbuckles, tower items, etc. (using flexible multistranded steel "aircraft" cable instead of EHS is *not* recommended) are available from tower manufacturers and dealers, including: Texas Towers, 1108 Summit Ave., #4, Plano, TX 75074; Phone: (800) 272-3467; Fax: (972) 881-0776; Web: <<http://www.texas-towers.com>>.

Klein clamps, Loos tension gauges, etc. may be purchased from Champion Radio Products, Box 2034, El Macero, CA 95618; Phone: (888) 833-3104; Fax: (530) 758-9062; Web: <<http://championradio.com>>

Come-alongs, thimbles, shackles, turnbuckles, etc. are available at local hardware stores.

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